embodiment, such a buffer sharing technique may share buffer space between different viewers that are served at different times within a cycle T. For example, as a first viewer consumes data starting at the beginning of the cycle T, its need for buffer space drops throughout the cycle. A buffer sharing scheme may make use of the freed buffer space from the first viewer to serve a subsequent viewer/s that is served at a point beginning later in cycle T, rather than reserving the buffer space for use by the first viewer throughout the cycle T. One example of such a buffer sharing strategy is described in R. Ng. And Jinhai Yang, "Maximizing Buffer and Disk Utilizations for News On-Demand," Proceedings of the 20th VLDB conference, pp. 451-462 (1994), which is incorporated by reference herein. In an embodiment employing such a buffer-sharing scheme, cycle time T may be alternatively calculated to ensure sufficient total available buffer space to allow continuous playback for a number of viewers by using the following revised formula that takes into account buffer space reduction that should be obtainable if a buffer sharing strategy is implemented:

$$T \le B_{max} / [(1 - B\_Save) * (\Sigma_{i=1}^{Nov} P_i)] \qquad (3')$$

In equation (3'), the notation "B_Save" is used to denote a constant in the range of from about 0 to about 1 that reflects the percentage of buffer consumption reduction due to buffer sharing.

Using the above relationships to balance sufficient I/O capacity and sufficient total available buffer space, range of cycle time T to ensure uninterrupted continuous playback may be defined in one embodiment for a single storage device by combining Equations (2) and (3) into a resource model equation as follows:

$$NoV * AA / [1 - (\Sigma_{i=1}^{Nov} P_i) / TR] \le T \le B_{max} / (\Sigma_{i=1}^{Nov} P_i) \qquad (4)$$

For an embodiment employing a buffer-sharing scheme, the following equation may be alternatively employed:

$$NoV * AA / [1 - (\Sigma_{i=1}^{Nov} P_i) / TR] \leq T \leq B_{max} / [(1 - B\_Save) * (\Sigma_{i=1}^{Nov} P_i)] \quad (4')$$

In the practice of the disclosed methods and systems, Resource Model Equation (4) may be employed for I/O admission control and the read-ahead estimation. For example, by tracking the number of the existing viewers who are served from a storage device (*e.g.*, disk drive) and monitoring or estimating their playback rates (*i.e.*, data consumption rates), Resource Model Equation (4) may be implemented in the embodiment of FIG. 1 as follows. Resource Model Equation (4) may be employed by I/O manager 140 of storage management processing engine 105 to determine whether or not system 100 has enough capacity to support a given number of viewers without compromising quality of playback (*e.g.*, video playback). For example, if values of I/O capacity and buffer space determined from Resource Model Equation (4) overlap, *i.e.*, no value of cycle time T exists that will satisfy Resource Model Equation (4), then system 100 cannot support all viewers without compromising quality of playback. However, if a value or range of values for cycle time T exist that will satisfy Resource Model Equation (4), then system 100 can support all viewers. Assuming the latter to be the case, Resource Model Equation (4) may be used to determine a range of cycle time T suitable for continuous playback. In the practice of the disclosed methods and systems, viewer data consumption rates (*i.e.*, playback rates) may be monitored in any suitable manner. In one embodiment, monitored data consumption rates may be reported data consumption rates determined in the application layer during session set-up.

Within a range of cycle time values T, Resource Model Equation (4) may be employed to give an estimation of read-ahead size, *e.g.*, see Equations (1) and (12), for each viewer based in part on consumption rates of each viewer, and in doing so may be used to optimize buffer and disk resource utilization to fit requirements of a given system configuration or implementation. In this regard, if value of cycle time T is chosen to be closer to the lower side of cycle time range determined from Resource Model Equation (4), then resulting read-ahead size is smaller, I/O utilization will be higher, and buffer space utilization will be lower. On the other hand, if value of cycle time T is chosen to be closer to the higher side of cycle time range determined from Resource Model Equation (4), then read-ahead size is larger, I/O utilization will be lower, and

buffer space utilization will be higher. Using this relationship between I/O utilization and buffer space utilization, Resource Model Equation (4) may be employed in one exemplary embodiment to maximize the number of viewers supported by system 100, given a designated I/O capacity and available buffer space, by adjusting value of cycle time T (and thus, adjusting the read-ahead size for existing and/or new viewers).

Resource Model Equation (4) represents just one exemplary embodiment of the disclosed methods which may be employed to model and balance utilization of I/O capacity and available buffer space, in this case using system I/O performance characteristics such as average access time AA, average transfer rate TR, number of viewers NoV, and their estimated consumption or playback rates P_i. It will be understood with benefit of this disclosure that I/O capacity and available buffer space may be balanced using any other equation, algorithm or other relationship suitable for estimation of I/O capacity and/or buffer space using estimated and/or monitored system I/O performance characteristics. In addition, it will be understood that other system I/O performance characteristics may be utilized including, but not limited to, performance characteristics such as sustained transfer rate, combined internal and external transfer rate, average seek time, average rotation delay, average time spent for inter-cylinder moves by read head, *etc.* For example, average transfer rate TR may be replaced by sustained transfer rate, and/or average access time AA may be replaced by the sum of average seek time and average rotational delay. In this regard, any single information management system I/O performance characteristic may be utilized alone or in combination with any number of other system I/O performance characteristics as may be effective for the desired utilization calculation. Further, it will be understood that system I/O performance characteristics may be estimated (*e.g.,* average access time AA), monitored (*e.g.,* number of viewers, NoV), or a combination thereof. In this regard, system I/O performance characteristics may be estimated and/or monitored using any suitable methodology, *e.g.,* on a monitored on a real-time basis, monitored on a historical basis, estimated based on monitored data, estimated based on vendor or other performance data, *etc.* Further information on monitoring of system I/O performance characteristics may be found, for example, described elsewhere herein.